



Globelics

## **The software industry in Uruguay in the crossroad: A critical context for their consolidation like a model of alternative development?**

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The industry of software and computer services in Uruguay presents a dynamic behavior that places it among the main exporters of the region. The development of the area took place without the existence of public policies that focused on it and without an active participation of direct foreign investment as a dynamizing factor, as is the case of other undeveloped countries. Nevertheless, in this dynamism shows signs that the sector faces a key context that will determine its later trajectory against the presence structural factors such as the educative system's incapacity to train enough human resources, slow pace in the creation of new enterprises and a weak insertion in the global value chains that structure the sector.

The study's objective is the analysis of Uruguay's national information and communication technologies innovation system. It involves as a first objective the characterization of each subsystem that composes it (academic subsystem, productive subsystem and government institution subsystems) on its complexity in relation to the learning and more complex knowledge generation capacity. A second specific objective is the identification and quantification of integration levels of the different subsystems themselves and between each other through the network analysis through the application of the graph theory, which implies a mapping of itself generating different network statistics. As a last specific objective the analysis shall be evaluated (quantified and characterized) the sector's participation in the global value chains that structure the information and communication technology world market.

The work is based in two substantive theoretical concepts: the concept of innovation systems and that of global value chains and the value capture in local spaces. In relation to the innovation systems theories a definition was seek that implicates a formulation in terms of a scientific concept—that is, empirically contrastable, applicable to different contexts and therefore comparable and conformed in more than an ex-post explanation. The proposed visions implies a diachronic and synchronous analysis as a means of perceiving the structural elements and at the same time the dynamic processes of interaction and exchange between the different composing elements. In this sense the use of network theory through graph theory and statistic network generation seems central. In order to develop this analysis qualitative techniques will be used (focused interviews to qualified informants, document analysis and observation) and quantitative techniques through the use of statistic analysis (principal components, regression and factorial analysis). The centrality of each of techniques depends on the characteristics of each of the analyzed components. The other central concept in our research is that of global value chains and the concept of value capture at local level towards the interior of the chains. We affirm that the concept is complementary to that of innovation system since a system's successful performance is determined by its capability of "capturing value" in local spaces towards the interior of the different global sectoral global value chains. This capacity would offer a comparative element to evaluate the different innovation systems' performance (national, regional sectorals, etc). In the measure strategies of this concept were central the documental analysis and in-depth interviews.

The main findings of the research may be structured in relation to each component and the system as a whole. In relation to the academic subsystem, the findings present evidence of the obstacle that implies the slow rate in human resource training in the area in order to be able to uphold the sector's growth level. This insufficient personnel qualified personnel has a double impact: in first place, it clogs the generation of complex learning spaces, such as

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groups in different academic institutions. A second consequence is the prevalence of informal learning spaces in the face of the hardship of consolidating formal or institutionalized spaces.

In relation to public policies, even though in the recent period intents of change have been identified, the existence of fragmented politics that operate on demand and present a limited use by the different actors composing different subsystem system can be noticed. At the same time, there persists lack of coordination between them and the lack of politics operating on the structural clogs for the sector's growth many times are found in the surroundings or in the system limits themselves (lack of an enterprising culture, clogs in new enterprise generation, persistence of corporative inertia in resource assignment, etc).

In relation to enterprises, in first place we detected a slow pace of creation of new enterprises in the sector and the absence of an enterprise spirit in the new generations of engineers. The scale problems with enterprises which size wouldn't allow the consolidation of complex learning spaces as well as investment in R&D. Another impact is the difficulty to enter the global markets, and the absence of alliance strategies with the key players at global level which have been relevant in some cases of successful countries (Costa Rica, India, Ireland).

At a system level, in first place a low level of integration between different components (relationships between enterprises, between academia institutions, between different public programs) has been detected. This lack of integration seems a paradox, since the smallness of the universes this should be facilitated. Secondly, the preeminence of informal relationships has been identified. These are not a stage in the formation of more formal relationships, but persist on its weakness, which represents a difficulty for more complex joint actions. Lastly, the lack of a strong interaction in the global value chains that structure the sector's global market represents a serious difficulty to generate more value and capacity to apprehend knowledge and skills that circulate on its interior.

### **Uruguay, the littleness and the globalization**

Uruguay is a small sized country located in the southern cone between the two largest South American economies; Argentina and Brazil. The country shows levels of human development that place it in a prominent position in the regional context in education and health coverage and life expectancy. Notwithstanding these good figures, in the last 30 years the country has showed a slowdown in the improvement of figures compared to that of the region and a growing gap with the values of the most developed regions. This process has been parallel to the difficulties the country has faced in the implementation of a successful model for insertion into the global economy. The scale and productive specialization of the Uruguayan economy determined an early crisis of the import substitution model of external insertion. The change in the international context and the difficulties for an alternative insertion implicated an opening process that reinforced the productive specialization in raw material exports (meat, wool, ). This process implicated a deep change in the industrial sector with the disappearance of entire branches of light industry developed within the framework of the ISI and the consolidation of agro-industrial complexes. That implied the low incorporation of added value of exportable goods. Thus since the mid-nineties an agro export model consolidated, of low added value primary goods, low growth levels (PNUD; 2005) and a productive specialization characterized by low levels of innovation and development (PNUD 2003; PNUD,2001). An indicator of this is the low level of expenditure in this item that was among the lowest in Latin America, being the average in the nineties (PNUD, 2005; Bértola, 2004) and concentrated in the academic sector, with the exception of agriculture export branches. The surfacing model's impact in the social structure implied the enduring or rise of inequality levels, the permanence of expulsion of population with higher than average education levels. The 2002 crisis (caused by external and internal factors) and the later recovery reinforced this model and its negative social consequences. The changes in the international context that took place in the last years, while having brought an explosive rise in exports, record GDP figures haven't implied a change in the international insertion model: it is a growing rise of primary goods exports. Nevertheless this growth has not rebounded in the chronic problems previously exposed: inequality and poverty levels persist despite the growth, a continuous process of expulsion of population with a

higher than average education level remains. The benefits of the new favorable doesn't have a direct effect in the rise of the population's life quality (PNUD; 2005).

#### The information and Communications technologies sector an unexpected phenomenon.

Within this context, an atypical and unexpected phenomenon has been taking place. Since the mid-nineties, a prominent performance in the information and communication technologies has been exhibited, that place it in the context of the region, although fairly distant from industrialized countries.

The first element that distinguishes the information and communication technologies in Uruguay is the level of penetration of the information and communication technologies. This level of penetration can be assessed firstly in relation to traditional telephony, that has always showed very high levels in the regional context, but in the recent period it stands out a penetration of personal computers and internet in households. The number of households that had personal computers ascend from 9,6 % on 1996 to 24,3 % on 2007 (Zamalvide, 2003; Pittaluga, Gonzalez, 2007) . In terms of the penetration of the Internet, since the beginning of the World Wide Web the country has had levels of users among its population placing it among the three first at regional level, 28 %. This level of diffusion of took place without the existence until recent years of state policies of promotion. Although the country's main telephonic company (ANTEL) is state owned, the diffusion process has been guided by the private market mechanisms (users in households or work before other public promotion strategies (communal centers, educative system). This diffusion matrix, as will be explored, presents a behavior that reinforces the exclusion processes prior to the diffusion of the technologies.

However, one of the most relevant events in relation to the sector is the emergence of a strong productive sector in the area of software production and informatics consultancy services, that has presented since the late nineties a group of enterprises with a clear exporting profile. The sector is constituted by a total of 300 most of which can be considered small and medium size enterprises, the most are local market oriented. These enterprises employ around 4,900 people. The enterprises are specializes on three main: Software Developers, Consultancies and Internet and data transmission (Stolovich, 2003) It is to be pointed out the eminent national nature of the enterprises. Unlike other emergent countries that have had a important performance (Costa Rica, India) foreign investment has not played a prominent role in the development of this sector. Even though recently some examples have appeared (for example, TATA consulting), this is not the norm, as the sector's participation in the direct foreign investment remains relatively low.

The emergence of software export and informatics consultancy begins to appear since the mid-nineties and has maintained a sustained growth to date. The export option seems an obvious choice in the face of a narrow local market. The exports have grown of 79,4 million dollars in the 2000 at 104,5 in the 2005 The export destination is mainly regional, so the main markets are in South and north America . However, there are two trends that stand out in the recent behavior: the hindering of the growth level of export rate, and the drop of participation of in the total volume of exports. The latter is a relevant indicator to analyze the weight of the sector as a driving force of a developmental model alternative to the agro-export model, especially if it is compared to its participation in other countries that have stood out in this point. Thus we can assess that compared to other countries that have taken it as a pivot towards development the country shows indicators (Dossani, 2005)

Likewise, in the discussion a series of signs have been shown that point out that the sector faces a context of change that can be key to its later evolution. The identification of the

growing shortage of HR as one of the bottlenecks for its growth, the difficulties of exports increase within the enterprise scale, the need of more dynamic public policies adjusted to the needs of the new local and international context of development of the sector are some of the elements that appear as critical in the current stage. In this sense becomes relevant the analysis the weaknesses and strengths of the sector as a strategy that may allow an alternative to the agro-export model based on low added value that has predominated in the last 20 years and has not boosted a rise in the performance of Uruguayan economy in the welfare of its population(PNUD, 2001; PNUD 2005) Seeks to analyze the strength of the different components that are key in the consolidation of a system that may allow the development of productive activities of high added value in the sector of information technologies and information In this sense it is key to examine separately the academic sector, the scope of public policies, both in themselves and in the relationships that they establish between themselves and the international surroundings to identify weaknesses of each and how they present. The early steps of the analysis of the doctorate investigation information are presented.

### Conceptual tools

The relevance of the information and communication technologies is linked to its centrality within the techno-economic paradigm that has been being consolidated since the late seventies. Given the assumption that the growing and depression processes we can identify in economic history are determined by the appearance of a conjunct of technologies that change the relative prices and become the key intermediate goods that structure them. (Perez 1986, 1998, 2005; Freeman, Soete 1995; Freeman, Louça 2002) It is clear that the information and communication technologies are the core of the new paradigm where information and knowledge become a core intermediate good for the capitalist dynamic. The processes of paradigm shift constitute moments of creative destruction where individuals and regions can change their position in the market. That is to say that these periods of change allow changes in the structure of relationships. (Perez 1986, 1998, 2005 ) The conjunction of the information and communication technology constitutes an opportunity for the development of innovations that may allow reposition regions and countries into a better situation.

The analysis of the capacities of the regions or countries to seize the opportunities the technology changes offer are given by a set of attributes that transcend the analysis of the enterprises. The approach that appears as more useful for the analysis of the capacity of the countries or regions for the development of innovations is the systemic analysis. Systemic analysis grants the possibility to develop a theoretical model that deepens causal mechanisms and the mechanistic explanations in order to explain complex phenomena, especially in relation to the analysis of objects that contain differentiate parts that establish multiple relationships among them. In relation to the capture of the possibilities that the technological changes facilitates the development of a theoretical model that allows a general explanatory. Notwithstanding, system analysis in relation to the innovation systems, although has been presented as a rich strategy, shows deficiencies as a formulation as scientific concept. These limitations can be assessed both in the formulation as general theory as operational strategy; these two limitations are manifested in the difficulties to develop comparative studies in order to contrast dissimilar systems.

The first formulation is developed by Freeman in order to shed some light of the capacities of the regions to develop innovations that explain the course of the different countries. The different course is determined by a conjunct of indicators that transcend the mere enterprises, the indicators of these systems are: the relationships between the academy and the productive sector, the rate level in investment and development to the interior of the companies, the relationships and exchanges among the companies, the relationships between the companies and the subcontractors and the clients, as well as the exhibition level of the companies to the

international competition (Freeman, 1987). Lundvall and Andersen outline an alternative focus to the innovation systems based on the experiences to the Nordic countries. In their theoretical model they are so relevant the relationships between users and producers as those that take place between the academic institutions and the companies. These social relationships are given in a determined context that conditions them in multiple ways, so that the possible channels of interaction that we can detect inside a system can be strengthened or discouraged depending on the local conditions under which they are produced (Lundvall, Andersen, 1988; Lundvall 1992). These postulates have consequences on the very definition of the limits of the system. This way, we move from a more restricted definition of innovation system (Freeman), that involves people and organizations that have as their fundamental tasks the development of innovation and development activities as well as the relationships that are established amongst themselves, in a more ample and abstract way. The limits of the system in this new definition are based on a more theoretical conceptualization, since it is defined as accumulative of learning through production, learning through use and learning through interaction between users and producers. (Lundvall, 1992)

The focuses around the innovation systems present two groups of problems that, although strongly related, we can contain in methodological-technicians and conceptual of general theory. The main difficulties in relation to the first group can appreciate them fundamentally in the strategy of their operationalization of concept of system. A first point arises when giving bill of the limits of the same one since all concept it implies an enclosed space of elements through which it is observed. In terms of the operationalization it implies the definition that elements compose the system and which form part of the environment. The second point in relation to the operationalization is related with the measurement of the studied system and the correct one the selection of technical of analysis that allow us to give it counts so much of its static elements as of its dynamic elements, the attributes of the elements that compose it to mediate as well as of the relationships that settle down among them. In relationship axis of problems to be relates basically with the inclusion of the contributions of the focus of innovation systems in a general theory that allows explaining their weight in the diversity of existent situations and in a general theory of the economic development

A possible answer to the problem of delimitating the object of study system is proposed by the sectoral systems of innovation approach (Malerba 2002;2004). Splitting systems of innovation analysis by activity branches allows setting up a limit to the elements considered inside the systems and those belonging to the environment. At the same time, it allows evaluating the relationship and co-evolution between the different sectoral systems. This approach allows specifying and grouping different elements through their inclusion in three key dimensions to evaluate the sectoral systems of innovation: knowledge and technologies, actors and networks and institutions (Malerba 2002;2004). Nevertheless, an open question is the relationship between the elements belonging to these three dimensions; for instance the relevance and weight of the institutions and/or networks and actors in each sectoral or national system. In this sense we must make explicit the reason of the relevance of each of these elements in the innovation processes.

The second problem in choosing the most suitable measuring techniques is heavily linked to the question of the most relevant limits and dimensions in each sectoral type. In this point it becomes important specifying the centrality of formal and informal relations, that is to say, the weight of inter-institutional and inter-personal relations in the analysis. This is not a minor question since it will determine the kind of measuring instruments to be used. Related to this point, we accept the premise that in modern societies informal and formal relations coexist and are complementary. This is clear also in the economic processes, where the relation between the actors in many cases is far from being impersonal and guided by a rational action of maximization. As the actor's interpersonal knowledge gains relevance it is important to analyze the characteristics of these relations and how they affect the economic dynamics. This involves

analyzing trust and reciprocity relations for social contexts particular to modern capitalism (Granovetter; 1995, 1993). Granovetter questions the notion that these relations are relevant only in primitive and pre-modern societies, and points out the importance of them in the dynamics and functioning of the capitalist system. The author identifies two central axes to characterize these relations: cooperation-trust and power-reverence. In the case of the first axis relations are horizontal and symmetric and there is no possibility for an individual to dictate what the other must do. Thus, the existence of mutual trust and horizontality would have as a consequence the cooperation among individuals. The second axis implies vertical relations in which one of the agents has the possibility to influence the other's behaviour, that is to say that an agent has power over the other (Granovetter, 1995,1993). Analyzing the antecedents of studies on innovation systems it can be noted that the relevance of informal relations seems to be related to the size of the region and/or country studied, as well as the level of complexity that the system has developed (Lundval 1992). In this sense, it can be asserted that in smaller territorial units there exists a greater relevance of the more informal type of relations in comparison to those of larger units. Nonetheless, the analysis of any process of social change show us that more complex social structures develop and need more stable, impersonal and formal relations, as well as the conformation of a system of experts (Giddens, 1993). Although the relevance of informal and personal relations will be more relevant in more reduced territories, the existence of formal and institutionalized relations accounts for a greater complexity and stability in the analyzed system (Bunge 1997,1999, 2000; Giddens, 1993). In the dynamic of consolidation of an innovation system the relations established can begin as informal relations that possibly may become more formal relations. *Thus, even though we must consider the weight of informal relations by the size of the studied territory size, and they are key to the conformation of any social system, there can be no complex social system in modern societies sustained only in these sort of relation.*

The two identified problems are key for the selection of the most useful complex system analysis techniques. Every system analysis implies, firstly, an analysis of the attributes that compose the system (synchronous), secondly the periodicity and characterization of the relations established among the composing elements (diachronous). The system analysis in many cases are focused in the identification and characterization of the composing elements but not in the intensity and characteristics of the links that are established among them. These two dimensions are indispensable to deepen the general characteristics of the system within itself as a whole of elements and links. A technique that allows us to model this type of complex systems is the network analysis system that supports an analysis of dynamic social processes developing a mechanistic explanation ( Bunge 1997,1999, 2000). Network modeling enables an analysis of the attributes of the different elements that compose them (nodes) and the relations established between them (links) (Scott, John; 2000). However, the most enriching element is that which allows análisis of the network characteristics itself through centrality measures (rank or grade, proximity and intermediation) that let detect the possible power sources within the network. This would be determined by the amount of contacts with which the network count, the proximity with the different members that compose the network and their ability to link through them other nodes. A second complementary análisis is that of cliques that allows the detection of existence of subgroups or subdivisions. Thus the analysis will allow to reveal the existence of said groups as well as their most relevant actors and those which allow their link with others (Scott, John; 2000). The use and application of graph techniques in the innovation processes has proven to be a useful field, since it allows to deepen in the dynamic dimension of the innovation process and identifying those individual or institutional actors that allow easing the connectivity between unconnected actors (Valente, T.W. 2005; 1996;1995). The use of these techniques in the case of innovation systems and processes in South America is an incipient field, but that has shown itself fertile for the innovation process analysis. Nevertheless, implies a specific strategy for data gathering in order to allow modeling the knowledge networks and the use of the graph analysis technique beyond a rough characterization of the networks (Albornoz, Alfara, 2006).

The second group of problems we pointed out has to do with the conceptual problems of the innovation system approach that may limit the possibilities of comparing different systems and evaluating their performance. This difficulty has been especially evident in the innovation system analysis of undeveloped countries such as in Latin America where these kind of studies always seem to conclude with the assertion of the existence of an empty void where the innovation system should be (Sutz; Arocena 1989, 1998). Here again it seems relevant to analyze the relation between the innovation system and the environment in which it works. The working of innovation systems is produced in a context, the global market, which presents a given structure and rules. In this environment and its characteristics condition the performance of the innovation system, constrain the consolidation possibilities and the evolution of the systems themselves. In this sense, different innovation systems, whether regional, national or sectorial, operate in a given world environment that some authors denominate "world system" (Wallerstein, 2002.). Thus it is pertinent analyze the form of the relationship that a system spatially located relates to its international environment. It is clear that innovation systems themselves suffer modifications and different historical phases that relate to the way in which the different national economies insert in that order. In that sense it can be stated that there is a co-evolution of the productive system and the institutions as a consequence of the changes in the international environment. The form that a given innovation system attains is a reflection of the form of insertion of the country in the international environment; at the same time it has a given historical form (Cimoli 2000; Katz 2000). National innovation systems have changed *forms of management of innovation and technological change* under the influence of change in the *global macroeconomical incentive regime*. In the Latin American case this meant a change in the key actors of the system, moving from the centrality of state institutions during a import substitution model to the emergence of new relevant actors, such as transnational enterprises within the model of a more open economy (Katz 2000).

It is a common place characterizing the processes commonly referred to as "globalization" as the economy opening, and the flexibilization of national limits. These have implied a steady rise of international commerce and a growing process of industrialization in undeveloped countries that however is not reflected in a decrease of the income gap between the countries of the north and south. This difference is due to the ability of the northern countries to appropriate the impacts of technical revolutions that are unevenly geographically distributed. The radical innovation processes are concentrated thus in the more developed countries, which are able to benefit from the prosperity cycles of the creative destructions (Arrighi, Silver y Brewer, 2001). However, the restructuring and dispersion process at global scale not only implies negative effects for undeveloped countries. The rise of international commerce, internationalization and interdependence implies new challenges and opportunities for undeveloped countries (Cimoli 2000). The new pattern of global economy supposes a greater interdependence between the countries, which implies more access to knowledge and technology than the previous model, where this was concentrated in the headquarters of the large transnational enterprises. *The improvement of innovation capacities is related to the ability to access international networks, which is where knowledge and technology are produced*. This change in the innovation circulation pattern at global scale allow many southern enterprises to access innovations which were unreachable in the previous model. This greater circulation of knowledge and innovation opens a "window of opportunity" to the countries of the south for developing strategies that use more intensively knowledge and innovation (Cimoli; 2000).

The possibilities of the new model are strongly related to the ability of the local enterprises to take part in the international networks of production. The relevance of these chains or networks can be assessed in the growing weight of the intra-firm and inter-firm international commerce. The firms have some sort of more or less stable agreement be that as suppliers, partners or enterprises that have developed strategic alliances. An analytic strategy

that intends to account for this growing phenomenon of local-global articulation of new forms of production is that of global chains of value (Gereffi; 2001, 2005; Gereffi, Humphrey, Sturgeon, 2005). Global chains of value are defined, on their most basic form, as the way in which technology is combined with intermediate goods and raw materials, and the way in which these are assembled, traded and distributed. An enterprise can be a link in this process or be vertically integrated. This concept unfolds parallelly with the notion of disintegration and fragmentation of the productive processes within industries and firms. The concept allows us to understand how firms integrate into the global economy, analyzing the way in which within this global system of production and distribution enterprises in underdeveloped countries access the global market and their impacts in the creation of opportunities, benefits and employment (Gereffi; Humphrey; Sturgeon 2002). The capacity and creation of innovations and their location in the local space is a key element in the manageability of the chain and its control. Thus, analyzing chains, the most value is located in the links that concentrate the most of the innovation and development activities are located in the developed countries. Chains involving a greater use of knowledge and innovation tend to have a more vertical form of management as a strategy of the central zones in order to reap their benefits (Gereffi, Humphrey, Sturgeon, 2005). It becomes relevant the concept of generation and seizing of value in the global production networks. The ability of a given territorial space for economic development and rising living standards to their inhabitants is determined by their ability to generate and seize value through global production networks (Henderson, Dickens, Coe; Yeung 2002). This ability is given by the quality and quantity of the relation framework (networks) that establish at a local level among firms and institutions, state owned or civil. The region's ability to generate value within the global production network is thus an approach that transcends the perspectives centered on the state or the enterprise and emphasizes the synergies that develop among different actors. The ability to generate greater levels of welfare in a given population in a context of globalization is determined by the capacity of the networks formed by these actors to generate and seize value within the global production networks. The local spaces can be strongly integrated into a given chain, but this integration can take place through the lower value generation and seizing links, which would imply a low impact in the population's living standards (Henderson, Dickens, Coe; Yeung 2002). Thus, the global chains of value and global networks of production are clearly complementary.

The benefit of using the concepts of global chains of value and global production networks is twofold. Firstly, it allows to analyze the way in which a given productive sector is structured at a global scale, overcoming the vision of a market with autonomous actors without mutual awareness. This way, it allows to analyze the way in which the network is building; from primary goods to those with greater added value. The form of participation that each local space shall have will be conditioned by the characteristics of the goods involved, especially the innovation and maturity content of them. Secondly, it allows to account for a structured environment in which different innovation systems are developed, and allows an element of comparison of the performance between different systems. Thus we can assert that *"the successful performance of the different innovation systems would be determined by the greater capacity to locate within its local space the links in the chain that concentrate the most value"*.

The ability to seize and generate value through the development of the system is key as a driving force for development, since it is heavily related to the quality of employment and living standards of local populations. Thus, the analysis of an innovation system implies, at a local level, the study of its different components and the quantification and characterization of the relations established within it, secondly, the ability this system as a whole has to locate within its territory the links in the chain that concentrate the most value.



## **Design and methodology**

Our research involves an unique case research design since we are referring to an object of research, the sectorial system of innovation of the information and communication technologies, that shall not be object of comparison within the framework of our doctorate research (Yin 2003) . Nevertheless, the proposed design fulfills two requirements that let it be considered as valid: it is based in explicit and justified assumptions in the concepts and precedents and indicators and methodologies that allow reapplication and comparison between similar systems in further research shall be used (King, , Keohane,; Verba 2000; Przeworski 1992)

The operationalization of our system's indicators implies the identification, quantification and characterization of "learning spaces" located in different analysis subunits that conform it. Thus we identify three sub-universes and analysis subunits among which we shall identify:

- ?? Academic institutions that develop formation and research activities in the area and the different types of learning spaces in them.
- ?? State and civil society institutions that implement actions in order to influence the sector's development; being through regulations, programs or events
- ?? Producing enterprises, and software providers, enterprises that offer consulting services in software, telecommunications and Internet.

Thus, our research shall have two levels: a macro analysis unit that shall be the national information and communication technologies innovation system. A second level, container in the former, that is integrated by three different registry and analysis sub-units that include within them the learning spaces that shape the system.

For the gathering of information related to each of the sub-units quantitative and qualitative methods were used. The centrality of each of the techniques varied in relation to the characteristics of each of them. There were implemented: focused interviews to qualified informants in relation to each of the analysis sub-units, research and documental analysis (laws, websites, publications, agreements, etc) and the analysis of secondary statistic data (users' of programs databases, innovation surveys to companies, etc).

During the field work it intended to identify the following space attributes: trajectory, human resources that integrate it, type of involved knowledge, contact and exchange with other similar or belonging to other analysis sub-units within the country and with the exterior.

It is distinguishable that due to the reduced nature of the sector, the implementation of 40 interviews to qualified informants yielded information about more than one of the analysis sub-units. Since it is common for the interviewees to belong to the productive sector, develop academic activities and have participated or participate (as part of advisory committees) of some of the identified programs. This allowed us a strong triangulation between the sources and the informants.

The proponed work implies two phases. In first place, analyze each of the sub-units on their characteristics as spaces of learning and their level of contact with other spaces, of their same type and within or outside the country. A second phase involves the modeling of the sector as a system and its characterization through the support of computer packages (usenet, pajek). In the present work the results of the first phase are shown (currently we are building the basis that may allow to model the network-system), we shall present the attributes of the different sub-units and the signs over the elements that the system shall have as a whole.

## **Primary discoveries**

### Academic field

In relation to the information technologies, the academic sector stands out by its youth. It can be assessed that the academic field of information and communication technologies had an early beginning but a late consolidation. Thus, although the Computers Institute of the Engineering Faculty - University of the Republic begins more than thirty years ago, the intervention of the university by the military government implied the departure of many professors towards the exterior or the productive sector and handicapped its consolidation as a space of research, concentrating on the formation at a more basic level. The return of democracy and the autonomy government of the university meant a re-foundation of the InCo since almost complete change in the professors staff and at the same time a steady growth of the students enrollment, what required the active participation of reincorporated professors, students and engineers both those who resided in the exterior and those who were performing activities in the private sector (Perez 2003, Zamalvide 2003; InCo 1998). At the same time, in the mid-eighties a legal change is produced that allows the existence of private universities, which implied the apparition of new universities. We must point out that the software engineering sector is one of the fields of knowledge in which the private universities have had a most relevant participation.

Currently, there are five institutions that have with grade courses in software engineering or related areas<sup>2</sup>. Nevertheless, upon analyzing the level of graduations of those it is evident that most of them (more than a 90%) derive from the InCo University of the Engineering Faculty of the ORT University. These are at the same time the two institutions that show the most age and consolidation. (Pittaluga, Gonzales; 2007)

A first element to take into account when analyzing the universities as spaces of learning is the low growth in the number of graduated from computer science careers. The number of engineers that graduated in the whole university/academic system rose from 191 in 2000 to 253 in 2005, which indicates a low annual growth (Pittaluga, Gonzales; 2007). These data don't seem to relate to the demand of a dynamic sector such as that of the information/communication technologies, besides the demand of the productive sector in general, and has been identified as one of the sector's "bottlenecks" (Pittaluga, Gonzales; 2007; Stolovich 2004). Other relevant fact in relation to the academic sector is the high participation of the students in the economically active population. The University of the Republic yield that 55.6% of the students carry out working activities (Universidad; 2007). Qualified informants told us this percentage is greater in the case of the students of the InCo ; likewise a differential element with regards to the media in terms of the university student's working insertion is that most of them do in activities related to their studies. Though we do not count with statistic data from private universities, qualified informants have acknowledged a similar phenomenon. This early insertion in their area of study accounts for the need of human resources in the area, since the advanced students supplement the lack of professionals caused by the slow increase in the number of graduates. In relation to the quality of the formation of the human resources, even though the argument of its quality as one of the factors that explain the sector's emergence has been repeatedly used (Stolovich 2003; 2004) there is no evidence regarding a better formation in relation to, for instance, the professionals of the region.

Beyond the qualified human resources formation activities we looked for in this universe of universities the identification of complex learning spaces such as research groups.

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<sup>2</sup> Computation institute, Engineering Faculty University of the Republic; Engineering Faculty ORT University; Autonomous university of the South; Engineering Faculty Catholic University Dámaso Antonio Larrañaga y Engineering Faculty University of Montevideo

Their relevamiento was carried out through survey analysis (CSIC, 2005), document analysis and interviews with qualified informants. As a strategy of counter-factic analysis it was identify also the groups in the area of microelectronics.

Chart 1 Research groups identified – software, microelectronic and telecommunication areas.

<b>Institution</b>	<b>Size (N° people)</b>	<b>Age (N° years)</b>	<b>Typology</b>	<b>Status</b>	<b>Integration (N contacts)</b>
ORT University	3	7	Base	Growth	Medium
ORT University	3	3	Base	Steady	Medium
Catholic University	1 (i)	2	In formation	Steady	Low
Autonomous university of the South	(3)	(6)	Base	Dead	Low
Computation Institute, Engineering Faculty Univ. of the Republic	3	8	Base	Steady	Medium
Computation Institute, Faculty Engineering Univ. of the Republic	2	2	Base	Steady	Low
Computation Institute, Faculty Engineering Univ. of the Republic	6	3	Base	Growth	High
Computation Institute, Faculty Engineering Univ. of the Republic	13	17	Consolidat ed	Steady	Very high
Computation Institute, Faculty Engineering Univ. of the Republic	9	12	Consolidat ed	Growth	High
Computation Institute, Faculty Engineering Univ. of the Republic	4	9	Intermediat e	Steady	Medium
Computation Institute, Faculty Engineering Univ.	10	10	Consolidat ed	Growth	Very high

<b>Institution</b>	<b>Size (N° people)</b>	<b>Age (N° years)</b>	<b>Typology</b>	<b>Status</b>	<b>Integration (N contacts)</b>
of the Republic					
Computation Institute, Faculty Engineering Univ. of the Republic	8	4	Intermediat e	Growth	High
Electronic Engineering Institute Faculty Engineering Univ. of the Republic	4	4	Intermediat e	Growth	Very high
Electronic Engineering Institute Faculty Engineering Univ. of the Republic	7	19	Consolidat ed	Steady	Very high
Electronic Engineering Institute Faculty Engineering Univ. of the Republic	2	3	Base	Steady	Medium

As showed in chart #1 there were detected a total of 14 research groups in the areas of computer science and microelectronics. They were characterized by age, number of members, a typology was elaborated (index that includes number of joint projects and publications, stability of members, future planning) its state (recent incorporation of members) and their integration with other academic or productive spaces of learning (number of contacts). The location of the groups takes place preponderantly in the institutes belonging to Engineering Faculty University of the Republic. Thus we can detect that although the public and private academic sector show an almost similar number of graduates, there is a very strong imbalance in relation to their academic production and developing research activities. There is also a relevant difference in the research groups identified in relation to their degree of development and consolidation. In the case of the groups belonging to the private universities they are groups in the process of consolidation, and one was detected that was finished. Specifically in the area of software no developed and stable research groups outside Computation institute, Engineering Faculty University of the Republic were detected. In relation to the difficulties for the creation and consolidation of groups there are some that are shared by all the institutions; most important of which being related to the retention of human resources against the demand and wage level of the productive sector. Against the shortage of human resources detected in the productive sector the wage levels offered by the academic activity are a poor motivation to remain in it. The factors that seem to reinforce the conformation of groups are: firstly, the existence of an institutional culture that encourages the creation of complex learning spaces such as groups composed of simpler groups, especially the cathedra. Secondly it appears the existence of the case of InCo – a constant academic support fund such as the PEDECIBA- Informática for postgraduate formation. In relation to the formation of research groups as complex learning

spaces a factor that would seem to be key is being user of the PEDECIBA- informatics program. Those institutions which did not count with it (whether public or private) denoted difficulties for the formation of qualified human resources and the maintenance of a specialization area through time. In the cases detected aside from the public university the main support of those institutions are the scholarship programs of universities and foreign countries. Nevertheless, these type of support with which the public university groups count are fundamentally of human resource formation, and it appears as a difficulty for their retention once concluded the formation stage. The main tool for retention is the presentation of projects as a wage complement, which are not a stable source.

Analyzing the level of connectivity of the groups it has been detected that most of them have a bad level of connectivity with the productive sector medium, high, very high, in this sense, the weakness that supposes the poor motivation to integrate the full dedication groups at the same time supposes an advantage. Analyzing the integrants of the groups we can determine that a very low percentage has a regime of full dedication to academic activities. Thus, most of the members of the groups develop professional activities within the productive sector. This has implied that the groups have a fluent contact with the productive sector, its needs and the area of opportunity that the same members of the groups be a form of contact with production.

The same can be applied to the academic institution as a whole. The existence of teachers that partially participates of the academic activities determines that there exists a constant and fluent contact with the productive sector. The contacts are carried out predominantly through informal links more than institutional agreements or the influx of specific public policies. This seems a relevant find since it implies that the integration has been based on face-to-face relations and personal ties. The question remains open about which sorts of limitations suppose the prevalence of relations of this type in a stage of growth and consolidation of the sector and how could this framework consolidate into a more formalized framework of relations.

A find of the field work is the identification of a second space of learning that appears as relevant: the final thesis works. Detecting a large percentage of students, and specially advanced students that are carrying out work activities in the sector of their final theses they turn in many cases in opportunities of development of solutions to problems detected throughout the course of professional development. It is a transitory learning space since it concludes with the work but that configures a space for learning and application of new knowledge and the development of innovations for problems that emerge in the productive sector. This entailment can come about whether by the insertion of the student or guiding of the professors, most of which form part of the productive sector. This way it turns into a linking mechanism between the academy and the productive sector.

### Programs and organizations

The whole of programs and organizations related to the sector is a very heterogeneous universe, even inside the institutions and programs developed within state influence. Some of the identified programs have been discontinued or have changed their orientation while others continue to operate. In the current administration innovation policies have been defined as a priority and profound changes were introduced in the research and innovation support and<sup>3</sup>

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<sup>3</sup> The government has created the , National Agency of Investigation and Innovation. ([www.anii.org.uy](http://www.anii.org.uy)), Cabinet Inter ministerial for the Innovation and the Agency for the Society of the Knowledge and the Electronic Government ([www.agesic.gub.uy](http://www.agesic.gub.uy)). These institutions fulfill new functions and tasks which were carried out by former institutions, whilst others such as the National Address of Science technology and Innovation ([www.dicyt.gub.uy](http://www.dicyt.gub.uy)) change their competence.

which has implied the end of many of the programs identified which functions are covered by some of the newly created institutions.

Within the analysis of programs and organizations as spaces of articulation of actors and knowledge transference we must take into account two levels: firstly the institution's formal design where the different actor's participation is apparent. A second level involves the networks that effectively participate, are created or reinforced through them. The latter and not the former determine the performance of the same and the objective accomplishment. In this sense, the functions carried out by these programs and organizations in the creation and consolidation of new learning spaces or the rise of interaction among them is relevant.

In the 1988-2007 period seven programs under the state sphere were identified: Basic Science development program- Informatics-Area, University of the Republic, National Address of Science and technology; Technological Development Program, National Address of Science and technology; Industrial Academic Council for the Technologies of the Information, Presidency of the Republic; Ingenio Program, Technological Laboratory of Uruguay; Software Testing Center, University of the Republic; Cluster and Productive Chains, Office of Planning and Budget; Program of Supports to companies with innovation projects, National Agency of Investigation and Innovation. Likewise, two organizations within the civil society were identified: Uruguayan Chamber of Information Technologies; Association of Computer Specialist of the Public Administration.

A first element brought out are the programs or institutions different initial stages; thus we can appreciate that the institutions have appeared in different contexts and in order to serve different contextual objectives, long term policies have not come about. This has, as we shall see, a clear impact on the profile of the programs carried out as well as the interaction capacity with other members. Also relevant are the differences on infrastructure, human and financial resources with which the detected programs and organizations count.

Basic Science development program- Informatics-Area: The program appears in the mid-eighties with the objective of recovering human resources in the basic areas (chemistry, biology, physics, computer science) through the funding of master and doctorate degrees and the repatriation of human resources in the exterior. It is managed by a council of delegates of the National Address of Science and technology and the University of the Republic; each branch of knowledge is managed by a committee and an area coordinator. The program counted since its beginning with foreign funding. Since the late nineties it has a support line for the consolidation of research groups. It is a program that can only benefit students and researchers of the InCo Engineering Faculty university of the Republic. The program has been key in the formation of human resources and the conformation of learning spaces within this institution. Most of the group members below 40 years (the generation educated after the dictatorship) have been users of the scholarship programs. The existence of this program could have been a key factor that explains the performance of the InCo against other universities (even institutes within the university itself). Its indirect impact is the conformation of a critical mass of postgraduate human resources in the sector that have participated in the productive sector and as professors in other private universities. The program continues to operate (with regular funding) finding itself in a process of redefinition against the new context under which the formation of HR is not the only relevant objective.

Technological Development Program: Comes up in the late nineties within the paradigm of recommendation of the international organisms (and resources sources, since 50% of the funding proceeds from the IDB) in terms of innovation support programs. It counted with a specific resources for the sector of information and communication technologies. There are three program modalities: fundamental knowledge generation (academic); support of innovative products (directed to enterprises); and support to the relation between groups and enterprises. Programs of this type are the only ones in the period that involved relevant support for the

groups and enterprises. Nonetheless, the analysis shows that only the consolidated groups and enterprises were in conditions to attain funding through these projects. Many of them were relevant to implement wage complements for the group members, which sustains their complete dedication to the academic activity and prevents their “leak” towards the private activity. Although a program directed from the National Address of Science and technology appears to show certain difficulties on its relationship with other programs and the different actors. The program was discontinued on 2007, and many of its functions are carried out by the programs directed towards enterprises of the Agency of Investigation and Innovation.

Industrial Academic Council for the Technologies of the Information: Emerges in 2001 and operates until 2007 depend of the presidency with the objective of rising the interaction between the academic and productive sectors. Its basic function was establishing contact between them. It had an advisor council from the different universities (public and private) and the productive sector (CUTI). However, due to the economic crisis it was never provided with the necessary resources and with the change of administration it was eliminated and its functions taken over by other institutions. It did not accomplish the goal of consolidating new links between the academy and the productive sector nor reinforce the existing ones. According to the involved actors, there was no starting proper diagnosis and there was no interest among the actors in the chosen format.

Software Testing Center: Emerges in 2004 and has as objective to be a space of relation between the academic field and the industry sector. Its objective is consolidating as a center of software trial for enterprises in the sector and those which don't belong to it yet. It evaluates the products and their adaptability to the specified platforms. It has financial support from the European Community and its members proceed from the academy (InCo Engineering Faculty University of the Republic) as well as the private sector (Uruguayan Chamber of the Technologies of the Information). It is a tool for linkage between enterprises and the academy since it enables the discussion around the creation of innovative products. It is a recent program but one which has had in its short trajectory a relevant performance. It constitutes on itself a learning space in relation to technology itself as well as establishing contacts between enterprises and research groups. Since its creation, the program has had a good user appraisal, as well as a high participation, especially of relevant enterprises of the sector.

Ingenio Program: It was Developer as a Incubator of companies and originates from the cooperation of the ORT University and the Technological Laboratory of Uruguay, it has financial support from the Multilateral Fund of Investments (FOMIN) of the Inter-American Development Bank. On its first callings one of the areas towards it was oriented was software development and consultancy. According to qualified informants there was not a significant number of relevant endeavors in the software area it was redirected towards other sectors of high contents of knowledge and innovation. The diagnosis for this redirection was, according to qualified informants, that in the current sector's situation there was no need for a program of this kind. The newly formed human resources in the area of software engineering prefer to join existing endeavors rather than beginning new ones.

Cluster and Productive Chains: It is a program that began its activities in 2007. It emerges in the sphere of the office of planning and budget of the presidency and it counts with financial support from the Multilateral de Inversions (FOMIN) of the Inter-American Development Bank. Its objective is raising the competitiveness of the sectors considered strategic through association with enterprises in order to enhance their export performance. It is formed by three components: elaborations and plans for competitiveness encouragement, non redeemable support for enterprises integrating the conglomerate and support for the reinforcement of the institutionally of the sectors. The information and communication technologies sector is one of the nine chosen strategic sectors. There has been only a single call to date and it has been pointed out that the opportunity sector where there were presented a larger number of projects

and high viability on the majority of small and medium enterprises of the sector. This is an element to point out since it implies the existence of a demand for these type of programs. There has not been an accumulation in order to develop an evaluation of them.

Program of Supports to companies with innovation projects, National Agency of Investigation and Innovation. This program has as objective funding for innovation projects of enterprises in the area of products, processes, organization, merchandising, management improvement. The support implies the assistance with subsidies that vary according to the size of the projects, the area of the projects and their level of impact. This type of support was previously driven by technological Development Program. Currently this program is on its beginnings and is on a process of evaluation of the firstcalls, so it is not possible to perform an assessment of it.

Uruguayan Chamber of Information Technologies (CUTI) This chamber arises with the consolidation of the sector in Uruguay. Its fundamental objective is related to carrying out enterprise, capacitating activities and lobby in behalf of the sector before the state given the absence of a clear policy towards the sector. Likewise it performs the sector statistic measuring, since the state delegated this duty to the institution. It centers its activities in the formation of enterprise resources in the area and information offering for the members. Lately it has developed a growing participation in programs (CAITI; CES), and has formalized its relationship mechanisms with the academic sector. Currently it seems to be geared towards smaller and medium sized enterprises which are the ones in need of most support. It is without a doubt the organization that has had the greater impact in the consolidation of the sector and its public visibility, especially in moments in which the state seemed not having it among its priorities.

Association of Computer Specialist of the Public Administration (ASIAP); It is a civil association of the computer specialist of the public administration. Its origin is a reactive process in part of a group computer specialist facing the state strategy (or lack of thereof) in relation to the use of information technologies. Thus it surfaces as a way to give the state "recommendations" in relation to a common purchase and use strategy (they were never taken into account). Since seven years ago it has developed relationship activities between the users towards the interior of the public administration and the producers (especially the annual ASIAP jornadas). Likewise, it carries out permanent formation activities in which members of the different academic institutions and research groups take part. Notwithstanding the impact of their actions in the generation of a specific policy towards the use of information technologies in the public administration has been characterized by its fragmentation.

**Chart 2 Main identified programs and organizations**

Name	Date of beginning-end	Type of programs	Nomination	Impact
Basic Science development program- Informatics-Area, (PEDECIBA-Informática)	1988-	HR formation Group consolidation	University of the Republic, National Address of Science and technology  Inter American Development Bank	High
Technological Development Program	1999-2007	Support for basic research on ICT Project support for	National Address of Science and technology	Medium



Name	Date of beginning-end	Type of programs	Nomination	Impact
(Programa de Desarrollo Tecnológico)		innovative ICT enterprises  Support for joint project between academy and enterprises	Inter American Development Bank	
Industrial Academic Council for the Technologies of the Information  (Centro Académico Industrial de Tecnologías de la información)	2001-2006	Coordination between academy and enterprise  Support for innovative theses	Precedence of the Republic  Uruguayan Chamber of Information Technologies  Public and private universities	Low
Software Testing Center, University of the Republic  (Centro de Ensayo de Software)	2004-	Software certification  Platform and stability tests  Relationship between academy and enterprises	Computation institute, Engineering Faculty University of the Republic  Uruguayan Chamber of Information Technologies  European Community	Medium
Ingenio	2006	Incubator of companies	Uruguayan Technology Laboratory  ORT University  Inter American Development Bank	Low
Cluster and Productive Chains,  (Programa de competitividad de Cluster y Cadenas Productivas)	2007-	Rise of competitiveness  Cluster dinamization	Office of Planning and Budget ; Presidency of the republic  Inter American Development Bank	??
Program of Supports to companies with innovation	2007-	Support for enterprises with innovation projects	Autonomous institution	??

Name	Date of beginning-end	Type of programs	Nomination	Impact
projects,  National Agency of Investigation and Innovation  Agencia Nacional de Innovación e Investigación				
Uruguayan Chamber of Information Technologies  (Cámara Uruguaya de las Tecnologías de la Información y la Comunicación)	1989-	Support to partner enterprises  Managerial and updating formation  Lobby role	Civil Association Enterprises	High
Association of Computer Specialist of the Public Administration  Asociación de informáticos de la administración pública	1994-	Updating courses  Event holding  Exchange	Civil association  Computer Specialist of the Public	Low

The main element that stands out is the recent lack of a strategic policy of promotion of the sector of information and communication Technologies. This can be assessed in the dates of appearance of the different programs. That is to say that a first characteristic is the late apparition of state programs and institutions promoting the sector. Nevertheless, we can identify three stages in the formulation of programs.

A first stage in which the only existing program was the PEDECIBA-Informatics. The existence of the PEDCIBA informatics was planned as a formation of human resources program in a strategic area where the country showed a considerable backwardness. According to the surveyed sources there was not planning for the generation of a productive sector in the sector . Nevertheless, the program had a considerable direct impact generating the preconditions for the generation of complex knowledge spaces such as groups within the organization towards which it was directed: the InCo- Engineering Faculty of University of the Republic. As counterfactual we can identify the difficulties experienced by other institutions within the public university (Electronic Engineering Institute, Faculty of Engineering University of the Republic) or private universities (ORT University, Catholic University ) to develop complex learning spaces within them. This deficiency makes them depend on other, more unstable, internal and external sources

for their implementation. Notwithstanding the impact of this program cannot be confined to the creation of groups within an institution. The general impacts implied the generation of a critical mass with greater levels of knowledge that mostly did not dedicate full time to the academy but they participated actively in the productive sector and formed human resources in universities other than the University of the Republic. In an indirect way it encouraged the conformation of informal networks with foreign universities and between the academy and the enterprise. The question that remains unanswered is that given its impact in the conformation of complex learning spaces should it be ascribe to a single university since it may be a learning space element towards the interior of other universities.

A second stage stands out by the apparition of programs through which it is intended to strengthen the relation between the academy and the enterprise and the generation of links between learning spaces. Within those we can include the PDT and the CAITI. Nevertheless, neither program had the expected impact, for different reasons. Firstly, there was not a proper articulation between them and the existing PEDECIBA-informatics program since each presented a different institutional attaches. Both programs, even though with the participation of relevant actors of the sector, did not accomplish the creation and consolidation of new networks. In the case of CAITI, apparently there was a difficulty to consolidate itself as a space of creation of links, the qualified informants state that among the participating actors, their own spaces for the creation of links took precedence before an institutionalized space. Among those in charge there is the perception that the participating institution networks were considered as an asset they not necessarily wanted to share. In the case of the PDT, although it was useful for funding some enterprise activities, the small sums involved and the bureaucratic paperwork constituted an obstacle for the enterprises. Among the linking components the program served those links already consolidated between the academy and the enterprises but not for the creation of new links. Evidence suggests that the main impact on this item was the ability to formalize preexisting informal relations through the signature of cooperation agreements between the academy and enterprises.

A third stage can be identified with the apparition of a third group of much more recent programs that are more alignment with the actors needs . In the case of these it is too early to evaluate their impact, nonetheless there are indications that they cover spaces required by the academy as well as the productive sector. Nevertheless, there are some points that might be an policy regarding the sector, especially the type of participation sought in the international market. Secondly, the need for a continuous monitoring and diagnosis of the specific needs of the academic and productive sectors, adapting their biddings to them and their relation with a medium and long term vision. Thirdly, the integration of the programs in a transversal way. As we previously analyzed, this was a deficiency of the former programs, and although in the new structure it appears a greater entailment, it does not appear to this moment very explicit in program practices but through informal channels. The generation of a greater critical mass and learning spaces within the academy and enterprise and the promotion of greater levels of exchange and integration seems to be an axis to reinforce for the conjunction of programs.

The main role CUTI carried out during the whole studied period in a great deal has intended to supplement the absence of these type of medium and long term integral policies towards the sector. It has accomplished an improvement in the managerial capacities of the sector, the articulation of enterprise networks and encouraged contacts. Similarly, it has given the sector public visibility to the point of integrating it into the political discourse and the public agenda. Nevertheless, as a *cámara empresarial* its role shows limitations since it has no direct influence capacity over the priorities of public policies. In this sense, an indicator of a successful performance of the state on this sector would imply the coordination of the chamber facing the reinforcement of public policies that fill the structural gaps the state has left in the past period.

## **Enterprises.**

As we quoted previously, the information and communication technology sector in Uruguay is formed by three fundamental sub-sectors; the software developing enterprise sector, the consultancy and computing services enterprises, and that of Internet and data transmission enterprises (Stolovich, 2003; Stolovich, Lescano 2004). The sector totals 300 enterprises which can be added up 1500 independent professionals that specialize in the area of consultancy and computer services. Regarding, 46% of them specialize in the area of software development, 24.7% consultancy services area and 29.3% internet and data transmission. Most of them, 85.5%, have a turnover under 500,000 (US) dollars (Stolovich; Lescano, 2004). They are young enterprises, since almost half of them started their activities in the nineties (Stolovich, Lescano, 2005). As we previously mentioned, even though the exports have shown a steady rise, there seems to be a drop in the increase of growth rate, these ascended to 104 million dollars in 2005, the last year with available data (CUTI Survey, Pittaluga y Gonzáles 2007).

Among the sectors that participate in the exports the developers sector stands out with a 58%, the consultancy and services with 37%, internet and data transmission with 5% ( CUTI Survey 2004). The sector with the greater export propensity over its total sales is that of developers with 22.9%, followed by consultancy and services at 14.6% and Internet at 2%. The export destinations are mostly countries in South America (43%), Mexico and Central America (28%), developed countries (25%) and the rest of the world (2.3%). Exports are concentrated in a handful of leading enterprises of larger scale while the overwhelming majority is oriented to the local market (Pitaluga Gonzales , 2007 Snoeck, 2007). An element to point out in this sense is the low participation of international enterprises in the exports, thus for 2004 these represented 3.7% of the total exports for the sector.

Contact with academia sector. For the analysis of these links we consider as sources of information the qualified interviews and the survey performed by the IEE of the Faculty of Economics and the United Nations Programs for Development (IIE; PNUD, 2005) and documental analysis. In the aforementioned survey, applied to a dynamic universe of innovating enterprises among which there was included a sub-universe of 51 enterprises of the software and telecommunications sector. We must take into account that this selection constitutes a bias regarding the entirety of the sector, since they represent the most dynamic core. 62% of the enterprises of the sector of information technologies declare having had contact with the university. Analyzing this relatively high value we must take into account that these are the most dynamic and thriving. According to what we shall reveal throughout our field work these are contacts through informal mechanisms, linkage of students with the productive sector through internships and the deepening and development of technological solutions through theses final projects. There are few examples of more formal relations that constitute macro agreements. Other indicator of the weakness of the formal relations is noticeable in the type of entailment of productive sector and academia projects through programs such as the PDT and the CAITI. Revealing these kind of problems it became apparent that the relation emerged from informal links, and that difficulties arose at the moment of formalizing these type of links. Thus we can assert that even though there are indications of a sustained relationship between the academic sector and the enterprises, in those predominate informal links, sporadic and not institutionalized. This can present limitations since it depends on the characteristics of the networks in which the individuals are settled which may present structural gaps that may prevent contact with learning spaces that would be more adequate for solving certain problems. In the same manner we previously analyzed in many cases these same networks are considered as active from groups and institutions and there is not necessarily interest in sharing them with individual or strange institutions. The ulterior modeling of this shall allow us to corroborate or this hypothesis.

Participation of programs or institutions. In relation to this item we count as sources of information the bases of existing programs and the aforementioned survey. There is a concordance in the gathered data in both sources. Thus, in the survey only a third of the enterprises of the sector declare having had at least contact with a science and technology promotion agency. This is concordant with the existent state program database analysis, such as the Technological Development Program, where we only could situate a very low percentage of enterprises in relation to the total universe. In the case of existent programs, until recently there was a perception that these programs did not adjust to the needs of his enterprises and implied sums on financing and bureaucratic proceedings that did not pay off the effort. It is to be noticed that the application of the survey is earlier to the development of new programs (CES, PAC) that seem to adjust better to the needs of enterprises in relation to product registration or elimination of barriers that small and medium enterprises have to export. In this sense it becomes relevant the second phase of our work; identify whether exists a differentiated profile between enterprises and organizations and networks that used these type of programs.

Relationship between enterprises The interaction between different enterprises of a given sector is a key element since it allows a rise in competitiveness and generation of large scale economies. A line of study centered on this axis on analysis is the clusters approach. To analyze this item we counted on data from the aforementioned survey and the analysis of documents and qualified informants. The data gathered by the survey account 54.9% of the enterprises of the sector have relations with other enterprises within the sector. In the same line of work on cluster process analysis in the information technologies in Uruguay it was found that the participation in the local spillover had a positive effect on the enterprise's exporting performance. The two mechanisms that present the most weight are the interactions and mobility of the work force (Kesidou, Romjin; 2005). These findings are concordant with documental analysis and qualified informant interviews. In this sense it has been observed that the group of most dynamic and exporting enterprises cluster around them a relevant number of enterprises with which they form a vertical or egocentric type of network (IIE, PUND, 2005; Snoeck, 2007). The question that remains open is analyzing the level of interaction and connection of the totality of enterprises of the sector, not only the ones constituting successful cases. There are some indications that there are difficulties for their integration with networks between enterprises that have a more horizontal structure, and the generation of confidence ties that these imply. The generation of programs such as PAC seems destined to be a tool for the allocation of these types of relations.

Participation in Global Markets. As we analyzed in the theoretic antecedents, the involvement of the local productive sectors in the global market is produced, in many cases, through different strategies of alliances and agreements. In the case of Uruguay the predominating strategy in order to enter foreign markets is that of business partnerships. This implies the development of different strategies for attainment of associates in foreign markets that market the developed product. The main factor for this choice is that this strategy involves a smaller level of inversion than the implementation of subsidiaries or affiliates in the target markets. Although it has been detected that the weakness of this strategy is the low motivation of the local associates for merchandising and product placement (Pittaluga, Gonzales, 2007). The second strategy used is the internationalization of enterprises through the concretion of affiliates. The sector has 49 offices in 15 countries. The participation of the affiliates in the foreign sales has been in a rate of one to four in relation to the volume of the enterprise's total exports (Encuesta CUTI en Pittaluga y Gonzales, 2007). The use of the franchise strategy has not been extended to a large sector of exporting enterprises, identifying only one that has developed it successfully.

The most recent internationalization strategy is outsourcing. This growth is parallel to the development of this strategy at global scale. The outsourcing strategy implies the territorial fragmentation of the process of production towards geographic spaces which main advantage are lesser production costs, that in the case of software are linked to smaller remuneration of involved personnel. This strategy has been increasingly used by transnational firms (Gerrefi

2001), and has been a strategy used by countries with a successful performance in the sector of information and communication technologies as a way of commencing it (Dossani; 2005). However, analyzing the export statistics of the sector in Uruguay the participation of this item in the total presents a swinging tendency, through the presence of an Indian enterprise since a couple years ago would imply a rise in the participation (Pittaluga, Gonzalez, 2007). One of the critics raised against this form of insertion is that it does not concentrate in the links of the chain with the most value, and that it concentrates in a competition from lesser wages. The question remains open whether it is viable this strategy in a country that has developed the sector with products with greater added value and sophistication.

The participation of the large transactional companies of the sector of information and communication technologies in the countries is in the distributors of their products. It has not been detected the presence of large players of the sector at global scale executing relevant activities in the country. Their activity in the country is concentrated in the adaptation of products to the requisites of the country. An indicator of the absence of relevant transnational enterprises in the sector is the behavior and evolution of the direct foreign investment in the country. Although in recent years the direct foreign investment has presented a historical growth, there has not been detected a relevant rise in the sector of information technologies (Banco Central del Uruguay 2005). This indicator, together with the participation of the outsourcing are proxy indicators of the level of participation of the sector in the global chains of the sector, and may be an indication of the need to develop a strategy that might allow the sector to connect between them. It is unlikely for a country the size of Uruguay to achieve a larger participation in the global market in the sector without some kind of insertion in the global chains of value that structure it. The key is to determine in which links of the chain the country has greater chances of seizing value.

### **Notes for a conclusion**

The presented findings appear in the initial stages of analysis of the information gathered during the field work of our thesis investigation. Although it is in its early stage of analysis we can draw some provisory conclusions regarding our object of research.

In first place, it has been detected that a factor that explains the dynamism of the sector of the information and communication technologies in Uruguay is the existence of a complex network of relations involving the academic sector and the enterprises. This complex system of relations integrates the different learning spaces that exist in the interior of universities and enterprises. Nevertheless it has been identified the existence of difficulties for the consolidation of complex learning spaces inside universities and enterprises. Related to the formers, the first difficulties are the lack of human resources and the low remunerations for academic personnel that makes the option of an academic type of insertion, especially full-time, unattractive for students. At the same time the identified programs for consolidation of human resources with an academic profile throughout the creation of postgraduate courses have as an objective solely the sector of public universities, which presents an obstacle for the consolidation of this type of spaces in other universities.

The existence of a staff of professors that at the same time participates actively of the productive sector is one of the most active mechanisms for the conformation of networks between the academy and the enterprise. The presence of teachers with this profile, together with the need of human resources enables contact of degree students with the productive sector before they finalize their studies. In this sense, the thesis projects constitute active spaces of learning that integrate the academic performance with the needs of the productive sector. Nevertheless, most of the identified networks are based on personal contacts and informal networks, being detected few networks between academy and enterprise in which there exist

explicit institutional agreements. This centrality of the informal networks can be an obstacle for the consolidation of more sustainable relations and the development of more complex projects that involve a greater volume of human and financial resources) and longer time terms.

As we previously affirmed, there existed until recent times a weakness of public policies addressing the sector. An indicator of this deficiency is the scarce generation of institutional spaces that maximize the articulation and consolidation of relations between the academic sector and enterprises, as well as enterprises among each other. The generation in the last years of new programs and institutions presents encouraging signs that this phenomenon may begin to revert.

In relation to the integration of enterprises between themselves it can be appreciated that there do exist a group of highly integrated enterprises around the leading enterprises. Nevertheless, the characteristics of the integration of the whole productive sector must be went into depth. The existence of these egocentric networks around leading enterprises may coexist with the presence of a larger group of less dynamic enterprises that show smaller levels of connectivity among them. This is a relevant point to deepen in the modeling of the group of networks that would form the sector's innovation system. In this sense we shall deepen into the characteristics of the networks and the existence of structural gaps on their interiors, and the difficulties and obstacles for integration that exist in the enterprises.

Related to the system's ability as a whole to seize value within the global market's sector, evidence shows that firstly, the generation and value seizing strategy taken by the most dynamic enterprises is based on the confirmation of their own networks in the exterior. This strategy presents difficulties, especially for new enterprises, given the size of the sector's enterprises in Uruguay. At the same time it has not been detected participation of the sector's enterprises into value chains through alliances with the leading enterprises nor through the participation of these enterprises as dynamizing actors in the sector through a larger direct foreign investment. The encouragement of the two aforementioned strategies may be a way to dynamize the sector in order to raise its export volumes.

Thus it can be asserted that the sector is in a juncture that presents three fundamental challenges that may determine its posterior trajectory. Firstly, the need for generating larger volumes of human resources that maximize the enterprises' growth capacity as well as the feasibility of more complex learning spaces towards the interior of the enterprises and the academic sector. Secondly, the consolidation of a group of institutions that ease the creation, and above all, the formalization of the links between the academy and the enterprise, that may enable larger and longer term projects that involve greater levels of complexity and innovation. Lastly, a complementation of the strategies of internationalization of the productive sector that involves a participation in the global chains of value in an attempt to withhold in the territory those links that imply the seizing and generation of the most value and the encouragement of direct foreign inversion in the sector as means of linking with the other relevant players at global scale.

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